Evaluating the Relationships among Psychological Distress, Executive Cognitive Function and Economic Factors on Mammography Use in Unaffected African American Women at Risk for Breast Cancer

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Objective: Psychological distress impairs the cognitive function involved in planning and decision-making (executive cognitive function), and hinders engagement in health promoting behaviors. This study examined the relationship among distress, executive cognitive function (ECF) and mammography use in African American women at risk for breast cancer.

Design: A cross-sectional sample of mammography screening adherers ($n=44$) and non-adherers ($n=16$) completed measures of psychological distress (Brief Symptom Inventory) and executive cognitive function, (Wisconsin Card Sort Task and Stroop Color Word Test).

Results: More than one-quarter of the high-risk sample had high levels of distress. Distress scores explained 12% of the variance in two ECF components (abstract concept formation and cognitive flexibility), suggesting a significant relationship between psychological distress and cognitive function. Distress scores and ECF measures did not predict mammography use; employment status emerged as the strongest predictor of mammography screening (OR=4.36, 95% CI: 1.18–16.07).

Conclusion: Elevated psychological distress is evident in high-risk African American women and appears to have an effect on the cognitive function involved in behavioral regulation and planning. Results also support the role of socioeconomic status as a significant predictor of mammography use. (*Ethn Dis*. 2010;20: 467–473)

Key Words: Distress, Cognitive Function, Breast Cancer Screening, African American Women

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Introduction

Psychological distress includes both anxiety and depression and has emotional and physiological manifestations.[1] Distress is prevalent and a threat to population well-being, and is particularly elevated among women. A recent survey by the American Psychological Association revealed that 55% of women experience psychological symptoms of stress; this figure is 6% higher than the national rate.[2] Sustained distress impairs several specific cognitive functions, such as memory and information processing speed,[3–6] and may disrupt engagement in health promotion behaviors such as getting age-appropriate breast cancer screenings. Women at increased risk for breast cancer have high levels of psychological distress,[7–9] and some do not engage in repeat mammography screening, a behavior important for reducing breast cancer morbidity and mortality.[10] In fact, reports have shown a significant negative correlation between psychological distress and mammography use.[7–8] It is necessary therefore, to understand the mechanism by which psychological distress is linked to mammography screening, and we proposed looking at the role of higher-order cognitive functions in explaining that relationship.

Research studies with populations experiencing clinical depression, anxiety, and psychological distress show that sustained exposure to psychosocial stressors can lead to impaired cognitive functioning including disturbances in attention, memory, and impairments in the operations involved in planning and behavioral execution – executive cognitive function (ECF).[3–6] A disturbance in any of the domains comprising ECF has been shown to significantly impact many functional behaviors including daily living activities.[11–13] Several studies have shown a significant negative correlation between impaired ECF and engagement in positive health behaviors.[12–14] As Cahn-Weiner and colleagues revealed, the severity of ECF deficits among community-dwelling older adults has explained variance in meal planning, dressing and self-feeding.[13] The question is whether ECF impairments might be a link between elevated psychological distress and mammography screening non-adherence. The goal of this study is to evaluate the relationship among distress, ECF and mammography use in unaffected African-American women whose family history places them at increased risk for breast cancer.

Methods

Study Sample

This study is part of a larger research project to assess social, cognitive and behavioral predictors of mammography use among at-risk African American women. We recruited sixty urban African American women ages 40–64 years, with no personal history of

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cancer and with first and second-degree relatives diagnosed with breast cancer. A first-degree relative is a mother, daughter, or sister with a cancer diagnosis, while second-degree relatives are cousins, aunts or nieces. Additional eligibility criteria included the ability to speak and read English, and no current substance use.

We recruited participants through several channels including: internal postings in oncology and mammography screening departments at a local hospital; outreach with relatives of breast cancer diagnosees who were participants of a high-risk breast cancer screening program at a cancer clinic; local media; and distribution of flyers at local health fairs and social events.

Investigators invited eligible participants to the testing facility for a one-time visit where respondents completed an informed consent form and HIPAA (Health Insurance Portability Accountability Act) document. Both documents were part of the full research proposal submitted to and approved by our university's institutional review board.

We divided eligible women into two mammography screening groups: adherers and non-adherers, and we calculated screening adherence using criteria reported by Phillips and colleagues.[15] Phillips' model is a stringent approach using the number of age-appropriate exams women report over their lifetime based on screening guidelines. To be considered adherent, the woman must: 1) have access to a provider; 2) have had a recent exam (defined according to self-report of date of last exam); and 3) report a number of exams appropriate for her age, based on screening at least once every year. Using Phillips' criteria, we identified 44 adherers and 16 non-adherers.

Measures

Respondents completed four assessments: a structured questionnaire; a psychological assessment of generalized distress; a cognitive assessment of general intellectual functioning; and neuropsychological assessments of executive cognitive function, specifically cognitive flexibility and mental planning.

Psychological Distress Measures

Brief Symptom Inventory (BSI; Derogatis).[16] This 53-item self-report measures psychological symptoms in medical and non-patient populations. Items are rated on a 5-point Likert scale (0–4); not at all to extremely. The BSI consists of 3 global indices: Global Severity Index (BSI-GSI), Positive Symptom Total (BSI-PST), and Positive Symptom Distress Index (BSI-PSDI). The instrument requires 5 to 7 minutes to complete.

General Intellectual Functioning Measures

Peabody Picture Vocabulary Test III, Form IIIA (PPVT-III; Dunn and Dunn).[17] This is an individually administered, untimed, norm-referenced test, with 204 test items grouped into 17 sets of 12 items each. Items are arranged in order of increasing difficulty. Each item consists of four black and white drawings on a picture plate. The respondent is asked to select the picture that best represents the meaning of the stimulus, which the examiner presents orally. The time of the test averages 11 to 12 minutes. This is an achievement test of vocabulary acquisition, and performance is indexed by standard scores ranging from 40 to 160.

Executive Cognitive Functioning Measures

Stroop Color Word Test (Golden).[18] This test measures the respondent's ability to shift perceptual mental set and suppress habitual responses based on changing environmental demands; it is a common measure of mental flexibility. In the first trial, respondents must read out loud names of color words printed in black ink – the word trial. The next trial requires respondents to name the various colors of a series of Xs – the color trial. The final trial requires participants to identify the color of various color names (GREEN) printed in a different ink color (blue) – the color-word trial. All three trials are timed (45 seconds) with the outcome being the number of words named, color of Xs identified, and color of colored names identified for each trial respectively. The color-word trial requires suppressing the reading response, and the outcome measure is a change score between the word trial and color-word trial. This change score is the last outcome measure that assesses mental interference; interference is the most sensitive index of executive cognitive function of the Stroop test.[11]

Wisconsin Card Sort Task (WCST; Heaton, et al).[19] The task is a measure of executive cognitive function requiring set shifting and problem solving. Respondents are asked to match cards that vary in color, shape and number to a stimulus card, on one or any combination of the three stimulus parameters. The respondent is not told how to sort the cards and must determine the correct sorting category from experimenter feedback of correct or incorrect. After ten consecutive correct card sorts, the sorting principle is changed without warning. The outcome measures include total errors (WCST-TE), perseverative errors (PE), categories completed (CC) and conceptual level responses (CLR). We used the computerized version of WCST (WCST-64 for windows).

Statistical Analysis

Data analysis included the following techniques: 1) examination of bivariate associations among predictor variables, outcome variables, and potential confounding variables to select relevant variables for analyses; 2) *t* test analyses of psychological and neuropsychological scores between adherers and non-adherers of breast cancer screening to identify the cognitive and affective

Table 1. Cognitive measures, and demographic characteristics of high-risk African-American mammography screening adherers and non-adherers

Characteristics	Adherers (*n*=44) Mean (% or SD)	Non-adherers (*n*=16) Mean (SD)	*P*
Employment †			
Full time	29 (65.9)	7 (43.8)	
Part time	7 (15.9)	1 (6.3)	
Unemployed	8 (18.2)	8 (50.0)	.04*
Brief Symptom Inventory Positive Symptom Total Score	14.83 (10.90)	22.04 (14.52)	.04*
Brief Symptom Inventory Positive Symptom Distress Index Score	1.13 (.15)	1.22 (.20)	.05*
Wisconsin Card Sort Task Conceptual Level Resp.	47.34 (20.37)	50.3 (27.87)	.65 ns
Stroop Color Word Task Interference	−7.77 (7.43)	−5.06 (5.01)	.13 ns
Peabody Picture Vocabulary Test Score Raw score	175 (10.30)	173 (12.28)	.51 ns

* $P<.05$.
† Chi square test used to calculated group differences; frequency and percentage scores reported.
ns, not significant.

measures to include in the final regression analysis predicting mammography use; 3) hierarchical regression analyses examining the relationship between psychological distress and executive cognitive function; and 4) step-wise logistic regression analysis with all relevant variables entered in the model.

Based on patterns of statistically significant correlations among the psychological distress scores and those of ECF, the number of positive symptoms of distress (BSI-PST), and the average intensity of distress symptoms (BSI-PSDI) were selected to assess psychological distress. The selected outcome measures for executive cognitive function were the interference measure of the Stroop test (Stroop-I) and Conceptual Level Responses of the Wisconsin Card Sort Task (WCST-CLR). We controlled for variables known to significantly correlate with executive cognitive function (age and intellectual functioning), by including these variables as covariates in later regression analyses, as they were significantly related to our ECF outcome measures.

In order to select variables to include in the final logistic regression predicting mammography use, we ran *t* test analyses on psychosocial variables that have been shown to relate significantly to screening (health insurance, income, and employment status); employment status was the only variable with a significant relationship to mammography screening and was included in the final regression model predicting mammography use. We also conducted *t* test analyses between screening adherers and non-adherers on the psychological and neuropsychological scores to identify those to include in the final model predicting screening adherence. A significant difference among adherers and non-adherers to mammography screening was evident for the indices of psychological distress (BSI-PST and BSI-PSDI) but this difference was not apparent for the neuropsychological outcome measures.

To evaluate the hypothesis that a significant relationship exists between distress and ECF, we conducted hierarchical regression analyses between the psychological distress and ECF measures (BSI-PST and BSI-PSD, and STROOP-I and WCST-CLR respectively). Finally, to evaluate the contribution of distress and economic factors (employment status) to mammography screening adherence, we conducted a logistic regression analysis with psychological distress and employment status as predictors of mammography utilization.

RESULTS

Psychological Status of the High-risk Sample

Table 1 shows demographic characteristics of adherers and non-adherers, and their scores on the psychological and neuropsychological measures. As seen in Figure 1, a significant proportion of the high-risk sample was psychologically distressed, with a measureable proportion of these women scoring high on the depression subscale of the Brief Symptom Inventory (BSI). The BSI scores revealed that approximately one-third (28%) had clinical levels of psychological distress, (T score ≥63 on BSI), with the high risk group elevated on the two study indices of psychological distress (PST and PSDI). Further, more than one-quarter of the high-risk group scored in the moderate to high range on the depression subscale of the BSI, with 7% scoring in the high range (moderate to high levels are one to two standard deviations above the mean of the non-patient norm group).

Relationship between Distress and Executive Cognitive Function

A regression analysis using intellectual function (PPVT) and psychological distress (BSI-PST), as predictors of executive function-abstract concept formation (WCST-CLR), showed a model that explained 16% of the variance in ECF. Psychological distress in the form of total positive symptoms of distress, contributed an additional 7% of the variance in ECF when the effect of intellectual functioning (PPVT) was statistically controlled; this is a statistically significant contribution, $P=.035$ (see Table 2).

The second regression analysis using age and participants' average distress level (BSI-PSDI) as predictors of ECF-

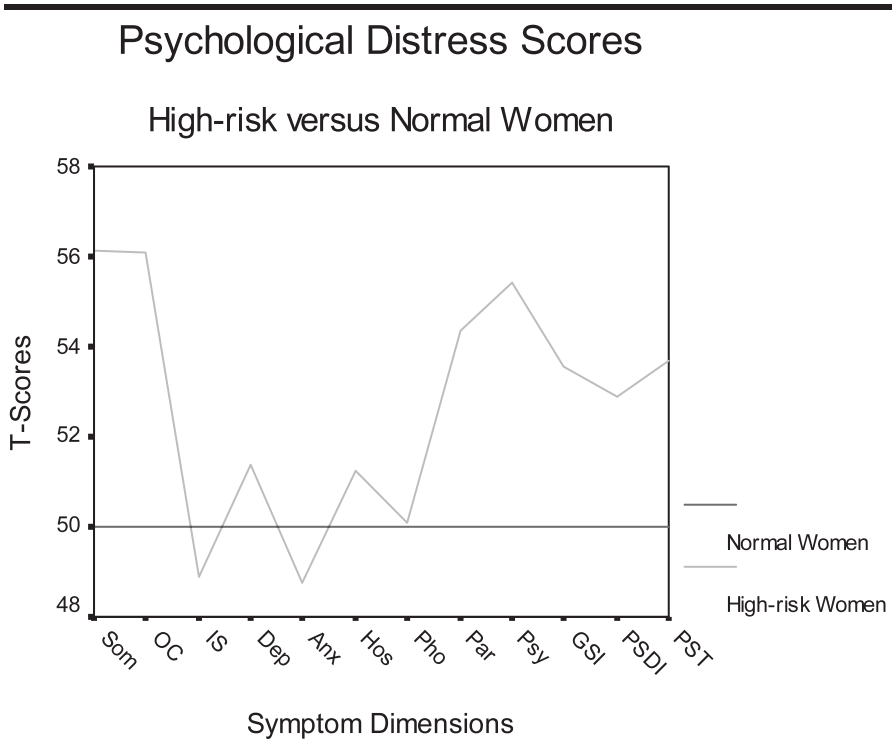

Fig 1. Comparison of psychological distress scores of the high-risk African-American sample versus normative adult non-patient sample
Note. Mean standardized scores for each psychological symptom dimension on the Brief Symptom Inventory for the total high risk sample and scores for an adult non-patient norm developed for the BSI. Som = somatization; OC = obsessive compulsive; IS = interpersonal sensitivity; Dep = depression; Anx = anxiety; Hos = hostility; Pho = phobic anxiety; Par = paranoid ideation; Psy = psychoticism; GSI = global severity index; PSDI = positive symptom distress index; PST = positive symptom total. Higher standardized scores = greater severity on the symptom dimensions; range of standardized scores are 0–100.

cognitive flexibility (Stroop-I), revealed a model that explained 20 percent of the variance in ECF. The distress measure explained an additional 5% of the variance in cognitive flexibility when the effect of age is controlled; this contribution is borderline significant, *P*=.055 (see Table 3).

Relationship between Cognitive Function and Mammography Use

Table 4 displays results of the logistic regression in which employment status emerged as the only significant predictor of repeat mammography use in the high-risk sample, *P*=.027, (Odds Ratio = 4.36, 95% Confidence Interval = 1.184–16.07). These results indicate that the odds of a person adhering to repeat mammography screening are 4.36 times higher for someone who reports being employed than for a person who reports being unemployed. Both indices of psychological distress (BSI-PST and BSI-PSDI) were non-significant contributors to mammography use. The model as a whole explained 14–24% of the variance in mammography screening.

Table 2. Regression model with distress scores predicting neurocognitive function (WCST-CLR scores) for the high-risk African-American sample

Steps and Variables	R^2	R^2 change	Sig. F change
Step 1:			
Peabody Picture Vocabulary Test	0.092	0.092	*P*=.018
Step 2:			
Peabody Picture Vocabulary Test BSI-PST	0.16	0.068	*P*=.035

BSI-PST = Brief Symptom Inventory (Positive Symptom Total).

DISCUSSION

A significant proportion of the high-risk sample experienced elevated psychological distress. Approximately 28% exhibited clinical distress using criteria defined by Derogatis,[16] with one fourth reporting moderate to high levels of dysphoric mood and affect. Results also revealed a statistically significant relationship between distress and impairments in two ECF dimensions – abstract concept formation and cognitive flexibility. These results suggest that sustained exposure to anxiety and depression can potentially impair the higher-order cognitive functions involved in decision-making and planning. The observed relationship between stress and cognitive function is consistent with a growing body of research demonstrating that sustained stress/distress can lead to general cognitive decline, including impaired short and long-term memory, reduced speed of information processing, and ECF deficits.[3–5] Impaired cognitive function is attributed to the release of stress hormones during periods of distress, and although these hormones are protective in the short-term, they can cause structural and neurochemical damages, including neural cell shrinkage, when they are overproduced.[20,21] Our results are important because they not only show that distress is significantly elevated in high-risk women, but by using

Table 3. Regression model with distress scores predicting neurocognitive function (Stroop scores) for the high-risk African-American sample

Steps and Variables	R^2	R^2 change	Sig. F change
Step 1:			
Age	.148	.148	*P*=.002
Step 2:			
Age			
BSI-PSDI	.202	.054	*P*=.055

BSI-PSDI = Brief Symptom Inventory (Positive Symptom Distress Index Score).

a non-clinical sample, our results provide additional support for the research that links stress to specific cognitive impairments. This outcome may provide support for the consideration of cognitively-oriented interventions when working with at-risk women experiencing elevated distress. Interventionists, therefore, might consider both the affective state (presence of anxiety) and cognitive factors (mild cognitive impairment, including ECF deficits) in order to effectively engage high-risk women in health promotion behaviors. Strategies that take into account potential mild cognitive disturbances are outlined by Martin and colleagues.[22]

Although the study revealed a significant relationship between psychological distress and ECF, impaired higher-order cognitive functioning did not differentiate screening adherers from non-adherers, and did not support a relationship between cognitive function and adherence to mammography screening. It is important to note however, that an inability to find a significant relationship between ECF deficits and non-adherence to screening does not mean that mild cognitive disturbances linked to sustained psychological distress, do not hinder engagement in health promotion behaviors. A potential explanation for the non-significant finding may be derived by noting that ECF is a multidimensional construct comprising several subsystems including but not limited to behavioral regulation, decision-making and planning.[23] Abstract concept formation and cognitive flexibility (two subsets of ECF measured in this study) are only two of many subsystems of ECF. It is important to note, therefore, that a disruption in only two subcomponents of a multicomponent system may not be sufficient to demonstrate global impairment of a complex behavioral response such as mammography screening. Although scheduling and attending mammogram exams require planning, the ECF components assessed in this study (abstract concept formation and cognitive flexibility) do not comprise the full complement of skills that instantiate the behavioral execution necessary for screening. Additional research, taking into account a broader array of executive cognitive functioning skills will be necessary to establish the relationship between ECF and this behavioral response.

Employment status emerged as the significant factor predicting screening adherence in this study's high-risk sample. In fact, results show that the odds of a person adhering to repeat mammography use are 4.36 times higher for someone who reports being employed than for a person who reports being unemployed. The results demonstrating the effect of employment status on health care use in this African American sample are consistent with previous reports revealing the importance of income on health care use in this population.[24,25]

Table 4. Logistic regression model with employment, distress and screening adherence for the high-risk African-American sample

			Confidence Intervals	
Variables	**Odds Ratio**	***P***	**Lower**	**Upper**
Employment	4.36	.027	1.184	16.07
BSI-PST	.977	.497	.914	1.04
BSI-PSDI	.129	.423	.001	19.29

BSI-PST = Brief Symptom Inventory (Positive Symptom Total Score).
BSI-PSDI = Brief Symptom Inventory (Positive Symptom Distress Index Score).

Study Strengths

This study has several strengths. First, we present a potential pathway by which psychological distress may be linked to mammography screening in women at-risk for breast cancer. Initial study results appear to substantiate one segment of this link with evidence of psychological distress significantly related to components of ECF; the second segment that links impaired cognitive function to mammography screening non-adherence remains to be demonstrated. The information substantiated by the first mechanism however, permits clinicians to consider a client's

Results also revealed a statistically significant relationship between distress and impairments in two ECF dimensions – abstract concept formation and cognitive flexibility.

cognitive status when developing interventions to improve health promotion behaviors among at-risk women.

A second strength is the fact that we assessed psychological distress using measures designed to classify each respondent as cases vs non-cases. This classification allows a clinical designation of respondents which allowed investigators to obtain a sense of the intensity of the measured distress relative to that experienced in the general population.

Study Limitations

The sample size is small for the statistical technique conducted. Based on equations presented by Tabachnick and Fidell,[26] a minimum of 84 participants are required to conduct a multivariate regression, and the current study used only 60 participants. However, despite the small sample size, the study was not wholly compromised, as we obtained a significant relationship between distress and components of executive cognitive function. However, a larger sample size coupled with a broader neuropsychological assessment battery might demonstrate a significant relationship between ECF and screening adherence.

A second limitation is the cultural homogeneity of the sample, which consisted entirely of African American women, potentially affecting the extent to which results can be generalized to other populations. There are however, benefits to using a predominantly African American sample; this community of women is disproportionately affected by breast cancer morbidity and mortality, and few studies exist that focus specifically on their neuropsychological indicators. Therefore, insights that may potentially improve health outcomes for this population are warranted.

A final limitation is the fact that information about mammography screening was obtained through self-reports, which may affect the accuracy of adherence data. However, research has shown a strong correlation between women's reports of mammography screening and recorded information, with up to 88% overall agreement between self-reports and recorded information for mammography use.[27–29]

CONCLUSION

Elevated psychological distress is evident in high-risk African American women and appears to have an effect on domains of the cognitive function implicated in behavioral regulation and planning. Clinicians may want to consider women's affective and cognitive status when attempting to increase health promotion behaviors. Although compromised ECF did not explain mammography screening adherence, additional research is warranted to evaluate the role, if any, that impaired cognitive function might play in women's engagement in health promotion behaviors. Economic indicators (employment status) remain an important predictor of mammography use in African-American women. Therefore, although mild cognitive disturbances linked to sustained psychological distress may emerge as an important predictor of mammography screening in women in general, socioeconomic factors are still highly relevant as predictors of screening adherence for this population.

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